USF UNIVERSITY OF SAN FRANCISCO

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Software Testing

Motivation

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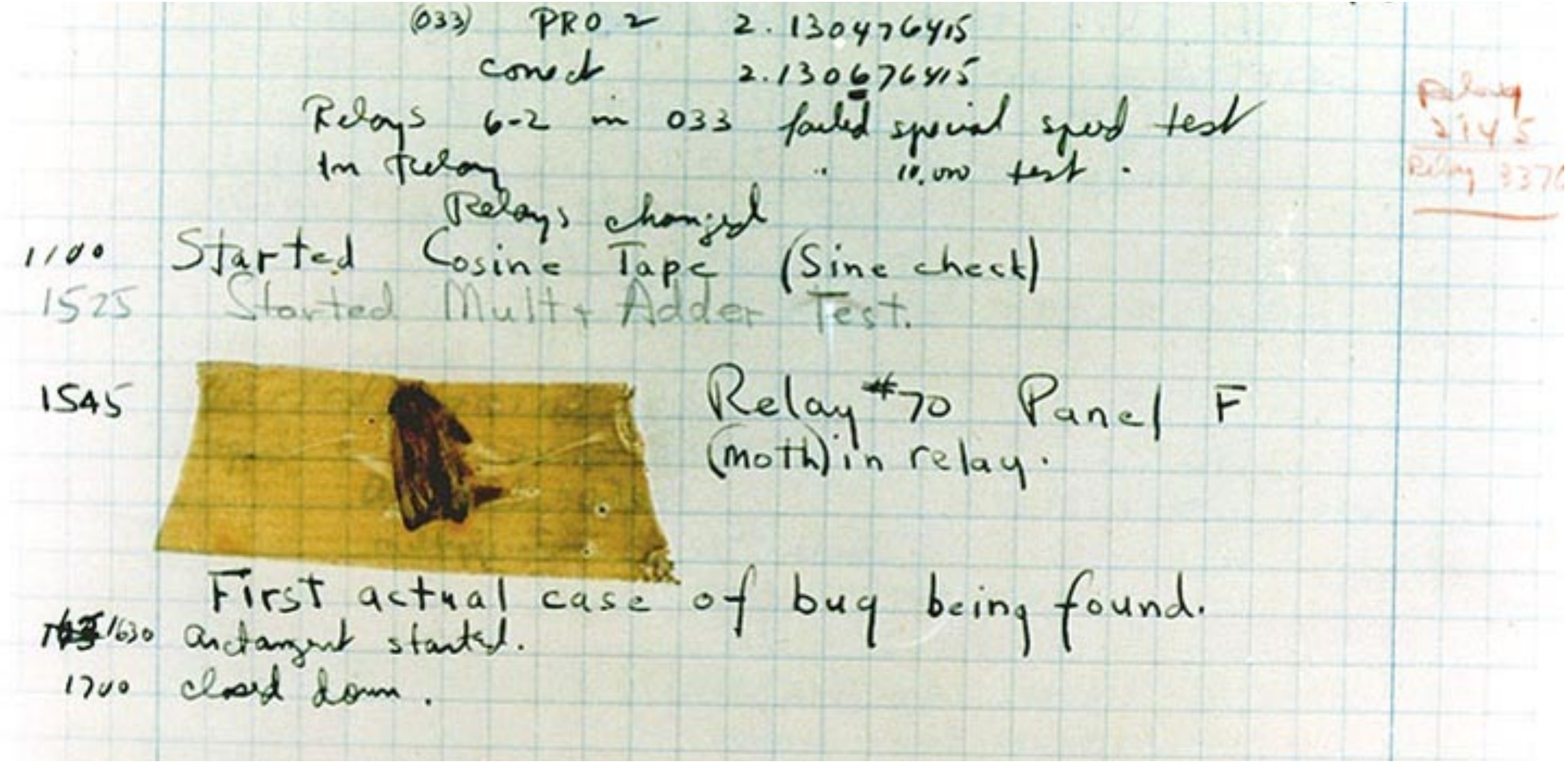
Programming is **debugging**. It’s the expectation that things won’t work. This is not something people bring up, just like they don’t bring up their medical history on the first date.

Most languages have constructs built in for catching failures, trapping them like wild animals, examining them, and, well, exterminating them. In time, as the relationship between you and a programming language blossoms, you come to realize that what truly characterizes a language is not what it does, but how it tells you what broke. **Most of your programming life will be spent trying to figure out what broke**, and if the computer helps you, maybe you can watch your kids play soccer.

- Paul Ford

https://www.bloomberg.com/graphics/2015-paul-ford-what-is-code/



(033) PRO 2 2.130476415
const 2.130676415
Relays 6-2 in 033 failed special speed test
in relay " 10.000 test.
Relays changed
1100 Started Cosine Tape (Sine check)
1525 Started Mult + Adder Test.
1545 Relay #70 Panel F
(moth) in relay.
First actual case of bug being found.
1630 Arctangent started.
1700 closed down.

Relay 2145
Relay 337

https://commons.wikimedia.org/wiki/File:H96566k.jpg

Why Does Software Have Bugs?

- Complexity
- Human error
- Unclear goals or requirements
- Unrealistic goals or requirements
- Limited resources
  - Time, money, expertise
- Poor communication
- Poor management
- And more…

http://spectrum.ieee.org/computing/software/why-software-fails/

Bug Finding and Elimination

- This is an important but inexact process
- Sometimes you can verify that a bug exists
  - Maybe… Demonstrate a specific test fails
  - Proves a bug… but is it in software or in the test?
- Usually you are unable to guarantee there are no bugs
  - Are there bugs in your code?
  - Are there bugs in your tests?
  - Are there bugs in your tests' tests?

Famous Software Bugs

- 1990 AT&T
  - Bug brings down AT&T's long distance switches
  - Leaves 60,000 customers without service for 9 hours
- 1993 Intel
  - Bug in floating-point division in Pentium chips
  - Leads to recalls and costs Intel $475 million

http://www.wired.com/software/coolapps/news/2005/11/69355

Famous Software Bugs

- 1962 NASA
  - Bug in transcribing formula into code
  - Results in destruction of Mariner 1 space probe
- 1996 ESA
  - Bug in converting 64-bit float to 16-bit signed int
  - Caused 1st Ariane 5 rocket (flight 501) to disintegrate

http://www.wired.com/software/coolapps/news/2005/11/69355

Famous Software Bugs

- 1985 Therac-25
  - Bug in radiation therapy device
  - Delivers lethal dose, killing at least 5 patients
- 2000 Multidata
  - Bug in radiation therapy interface
  - Physicians using it were indicted for murder

http://www.wired.com/software/coolapps/news/2005/11/69355

More Recent Bugs?

- 2011 Sony: Multiple breaches resulting in theft of credit cards http://www.techhive.com/article/226875/sony_online_entertainment_hacked_12700_credit_cards_stolen.html
- 2012 Knight: Bug in HFT software results in $460 million in losses http://pythonsweetness.tumblr.com/post/64740079543/how-to-lose-172-222-a-second-for-45-minutes
- 2013 Affordable Care Act: Website bugs affect program rollout http://www.npr.org/blogs/itsallpolitics/2013/10/22/239848684/for-democrats-obamacare-web-woes-create-2014-headache

http://en.wikipedia.org/wiki/List_of_software_bugs

Apple iOS Fail 2014

```
if ((err = ReadyHash(&SSLHashSHA1, &hashCtx)) != 0)
    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &clientRandom)) != 0)
    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
    goto fail;
    goto fail;
if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
    goto fail;
err = sslRawVerify(...)
...
```

http://www.dwheeler.com/essays/apple-goto-fail.html

Why Should We Test Software?

- Software has bugs
  - Human error, complexity, limited resources, etc.
- Software bugs are difficult to find and eliminate
  - Unable to guarantee software is bug-free
- Software bugs can have serious consequences
  - Loss of money, reputation, resources, or worse

TED: All Your Devices Can Be Hacked

by Avi Rubin, 2011

http://www.ted.com/talks/avi_rubin_all_your_devices_can_be_hacked?language=en

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